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APOLLO MONTHLY PROGRESS REPORT
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NAS9-150

January 1, 1965

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November 16 to December 15, 1964

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ABSTRACT

Brief, illustrated report of Apollo Program progress for the period, highlighting accomplishments, milestone achievements, and a continuing summary of the Program.

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ILLUSTRATIONS

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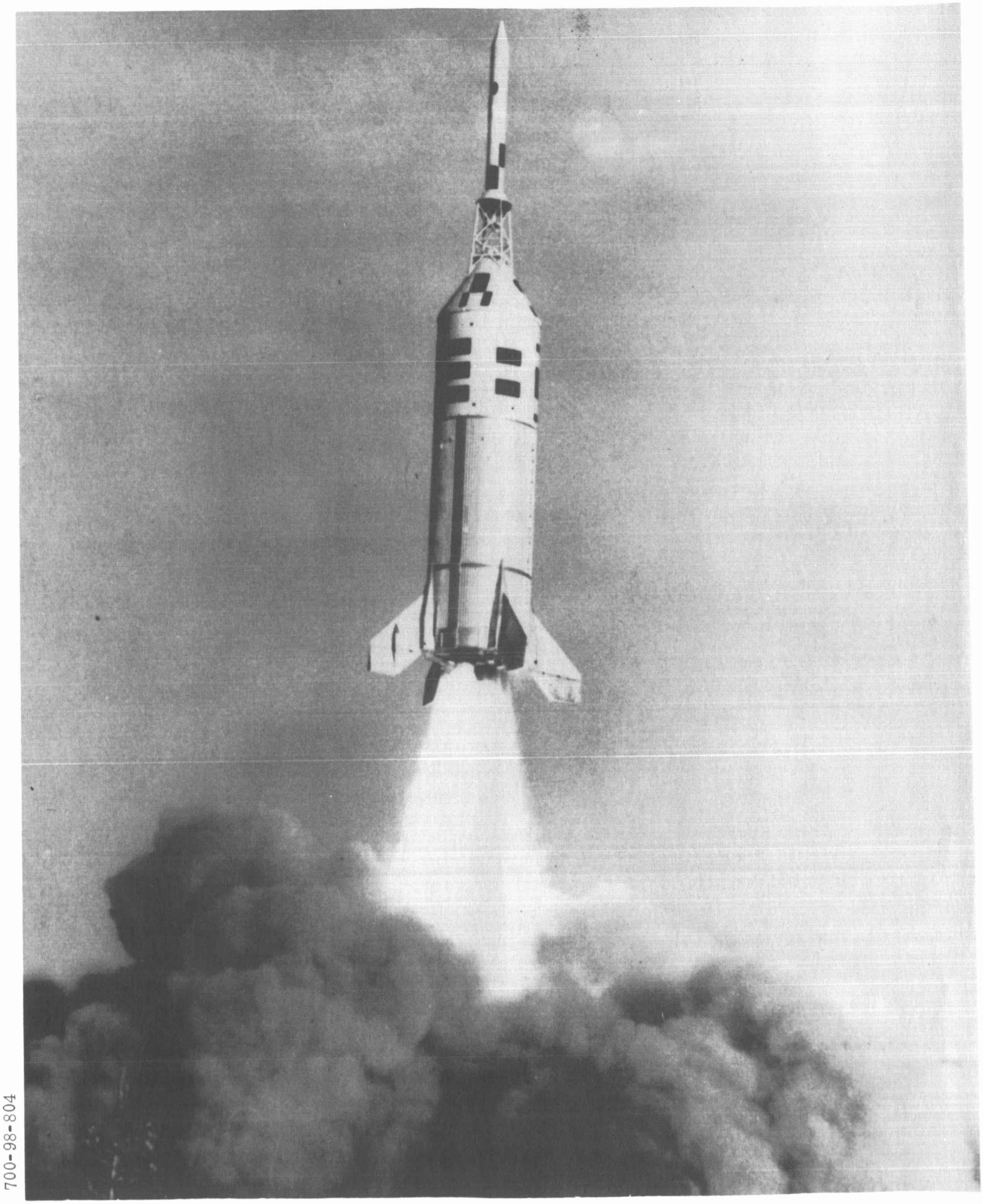

700-98-804

Figure 1. Boilerplate 23 Launch

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PROGRAM MANAGEMENT

STATUS SUMMARY

At 8:00 a.m. (MST), December 8, 1964, the fifth flight test in the Apollo Program was successfully conducted at White Sands Missile Range (see Figure 1). Boilerplate 23 was launched atop a Little Joe II booster. The purpose of the vehicle was to test launch escape operation, using the boost protective cover and canard deployment to orient the descending command module. The operation—from countdown through recovery—occurred as programmed. Details and initial analysis of the flight test are contained in the Development and Operations sections of this report.

The tenth and last firing of service propulsion engine 0006 was conducted on December 9, concluding the first test series. The engine was removed from the test fixture on December 11. Modifications of the test structure will be performed during the next report period, in preparation for the next series of firings.

Service propulsion subsystem (SPS) proof pressure and leak tests of spacecraft 001 were completed during the report period, and the service module was prepared for shipment to White Sands. Shipment is expected on December 17.

The initial system individual checkout—Phase I of boilerplate 14 testing—was completed during the report period ahead of schedule. As a result, the initial acceptance checkout equipment (ACE-SC) tests (Phase III) were started on November 22, ahead of the planned start date of November 27. The tests were completed on December 1, significantly ahead of the scheduled completion date of January 8, 1965. Phase III (support to spacecraft 009) was begun immediately after the completion of Phase II, ahead of schedule. The installation of sequencers and associated wire harnesses is in process.

Gimbal stability checkout of the service propulsion engine for boilerplate 14 was completed on December 8. Crew couches, acceptance checkout carry-on equipment, display and control panels, and electronic packages were removed from the command module for equipment modification and wiring.

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Painting operations on the service module of spacecraft 006 were completed, and the module was moved from the manufacturing area to the high-bay area (Building 290) on December 11.

The critical inner-structure closeout weld operations on the command module of spacecraft 008 were completed on December 10, and X-ray inspection of the operation was completed on December 11.

The launch escape tower for boilerplate 27 was shipped to the Marshall Space Flight Center on November 18.

ASSOCIATE CONTRACTOR ADMINISTRATION

S&ID support of the activation of the General Electric acceptance checkout equipment (ACE) ground stations 1, 2, and 3 was completed during the report period.

DEVELOPMENT

SYSTEM DYNAMICS

Aerodynamics

The boilerplate 23 flight at White Sands Missile Range (WSMR) on December 8 successfully demonstrated abort at high dynamic pressure using the launch escape subsystem (LES) with canards. Jettison of the boost protective cover with the LES tower was also successfully tested. Another objective of the flight was to provide test conditions approximating the limits of the emergency detection subsystem. Little Joe II produced a nominal boost; however, abort was initiated about two seconds earlier than planned, resulting in higher than planned dynamic pressure at abort and a smaller angle of attack at pitch-up. Table 1 shows actual and predicted abort conditions.

Table 1. Boilerplate 23 Abort Conditions

Parameters	Time After Lift-off (sec)	Altitude (ft)	Mach No.	Dynamic Pressure (psf)	Angle of Attack (deg)
Actual	35.6	31,000	1.56	1,030	-5.5
Planned	37.5	33,825	1.45	777	-8.3

Following abort, the Little Joe II broke up. The canard deployment signal was received on time, and motion pictures revealed satisfactory deployment. The apogee altitude was about 50,000 feet. (The planned apogee was 49,400 feet.) The barostatic switch for LES jettison closed at the predicted T + 120 seconds, indicating nominal descent. The dual drogues deployed and disreefed as planned; all three main parachutes deployed, disreefed, and inflated fully; and landing occurred at T + 443 seconds—essentially as predicted. Postflight inspection of the command module indicated that separation of command and service modules was not clean. First-look analysis shows that this problem was caused by the abort being initiated at high dynamic pressure prior to tail-off of the Algol booster motors.

Earth Landing Subsystem (ELS)

Performance of a three-parachute cluster, with 75 percent of the material removed from the fifth ring of each, was tested in drop 70 at El Centro, using a bomb test vehicle. Visual observation showed that all events occurred as planned.

Drop 71 was performed using a bomb test vehicle to test the degree of main-parachute load sharing for a two-parachute cluster with a one-second time differential in disreef, and to determine the effect of increased command module weight on main parachute loads. Artificially induced blanketing of one parachute resulted in the other parachute experiencing most of the maximum load of 27, 000 pounds (equivalent to 25, 000 pounds for a command module due to the command module's greater drag area). One gore of the highly loaded parachute split; an investigation of the cause is in progress.

The aft heat shield used in the first boilerplate 28 drop (see Figure 2) simulated the spacecraft configuration with the exception that the honeycomb sandwich consisted of the core bonded to the two face plates instead of being brazed, and with the exception of differences in core pattern. The configuration to be used in the second boilerplate 28 drop test (see Figure 3) will consist of the spacecraft 007 aft heat shield with a second outer face plate bonded to the first and reinforced with bonded doublers. A new unitized (single bonded unit) aft bulkhead will be installed in this test vehicle. This is the mainstream effort to solve the aft heat shield impact problem.

A backup configuration has been developed with a keel-shaped protuberance (see Figure 4) and possibly a gap between the aft bulkhead and heat shield to provide elasticity. This configuration is known as the modal onset separation entry subsystem (MOSES). Tests and analytical studies in support of the next boilerplate 28 drop and the backup MOSES configuration are detailed in the Structural Dynamics and Structures sections.

MISSION DESIGN

Block I and Block II basepoint missions were developed, together with spacecraft attitude ground rules and criteria. These data will serve as basepoints against which the following can be evaluated: (1) the effects of changes in missions and (2) modifications of subsystems affecting spacecraft attitudes. The data reflect the maximum range of conditions for nominal flight. They do not include extremes such as lunar excursion module rescue, reaction control quadrant and navigation failures, and other emergency contingencies. The Block I 10. 3-day basepoint mission is typical of a manned

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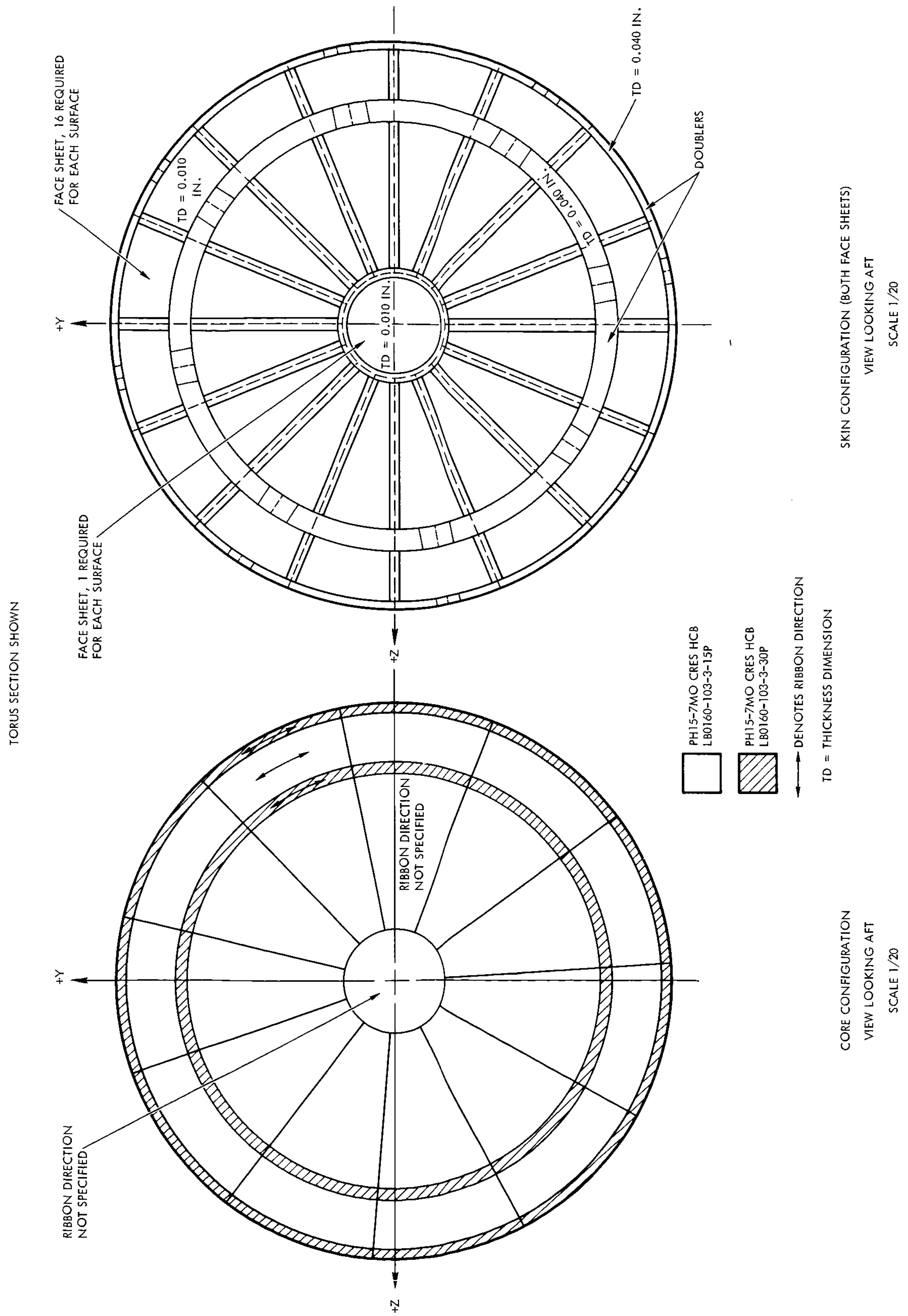

Figure 2. Aft Heat Shield Configuration, Boilerplate 28, Drop 1

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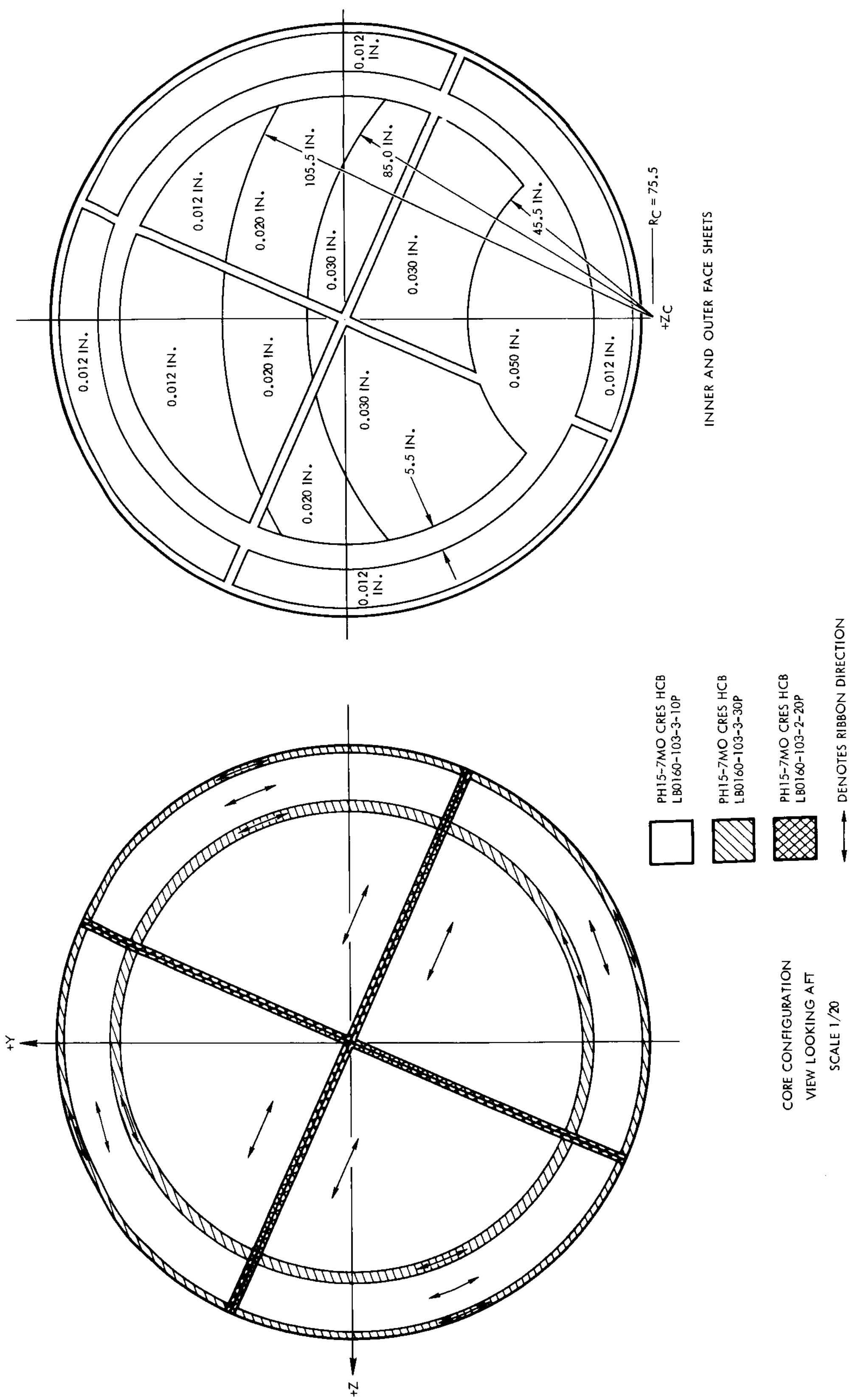

Figure 3. Aft Heat Shield Configuration, Boilerplate 28, Drop 2

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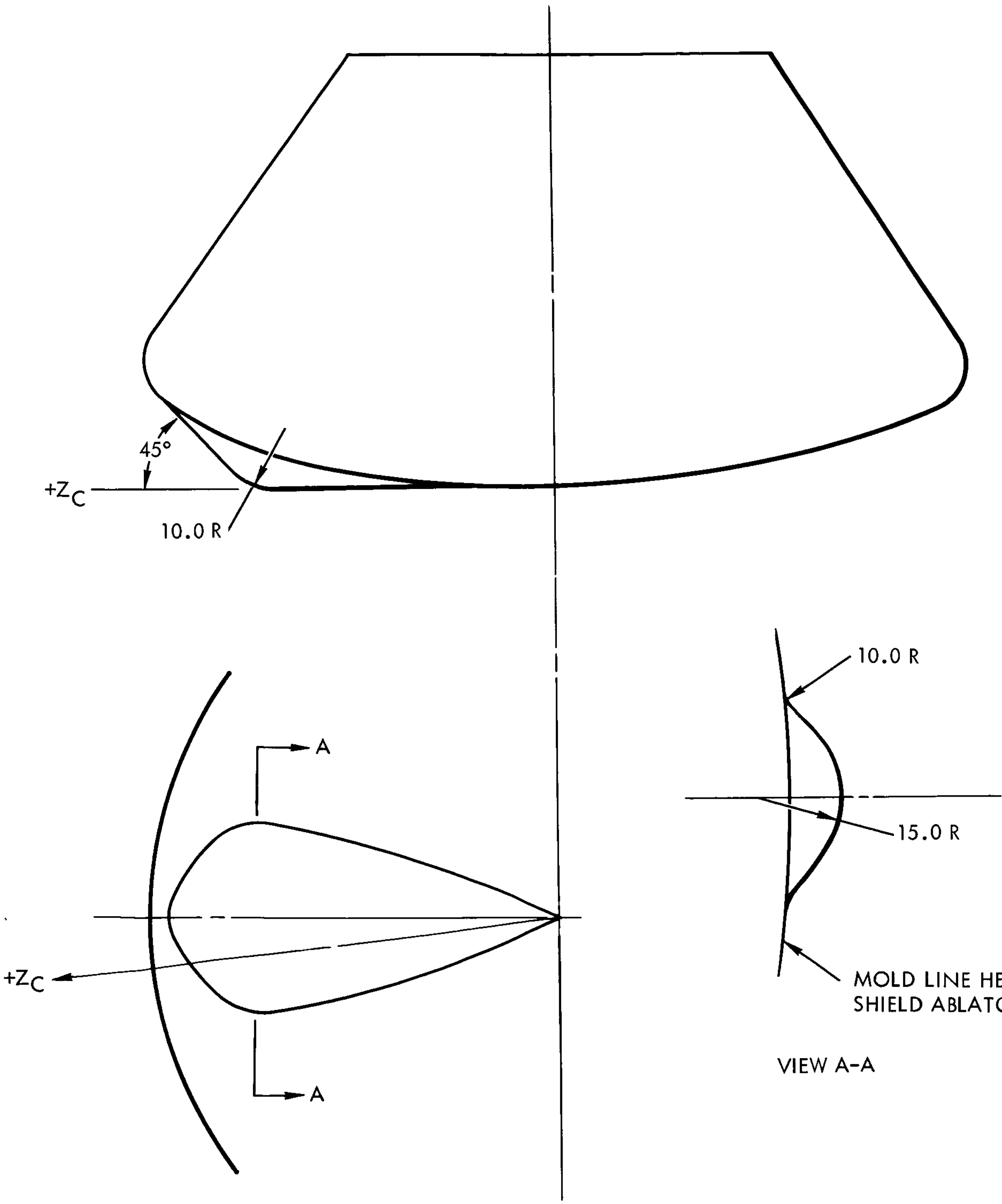

Figure 4. MOSES Configuration 8

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earth orbital flight of long duration during which mission events such as simulated docking and Hohmann transfers occur. The Block II 8.3-day basepoint mission employs the design reference mission of the Apollo mission planning task force (AMPTF), and includes a 35-hour stay of the lunar excursion module on the moon.

An error budget study was completed for Block II powered maneuvers in the manual thrust vector control (TVC) backup mode to achieve a total spacecraft pointing error of 1 degree root mean square (RMS). The 1 degree total RMS was established previously, as reported in the October 1 issue, for transearth injection and midcourse correction in the stabilization control subsystem (SCS) backup mode. This 1 degree total RMS pointing error must not be exceeded in order to comply with ΔV propellant allocation for midcourse correction and required entry corridors for crew survival. Table 2 shows the error budget for the SCS and TVC backup modes. The error allocation for the SCS mode has been adjusted for compatibility with the TVC mode.

Table 2. Error Allocation Budget for Total Pointing Error of 1 Degree RMS

	Backup Mode	
Error Source	Normal SCS Mode (Deg of arc)	Manual TVC Mode (Deg of arc)
Optical alignment errors	0.067	0.067
Navigation base alignment	0.333	0.333
Gyro mounting error	0.100	0.100
Reference subsystem errors	0.340	0.340
Attitude indicator errors	0.107	0.107
Crew error (spacecraft rotation controller)	0.200	0.200
Structural deformation	0.530	0.530
Attitude deadband	0.167	0.167
Thrust line computation uncertainty	0.100	0.100
Steering display error		0.107
Crew error (steering)		0.300
TVC dynamics	0.584	0.584
RSS total pointing error	0.976	1.000

A detailed analysis is in progress to determine the effect of the recently revised subsystem and mission requirements (described in the last report) on the propellant requirements for the service module reaction control subsystem (RCS). Although these subsystem changes result in increased service module RCS propellant requirements, various methods to alleviate these increased requirements are being investigated in order to avoid a possible increase in propellant tank size. Mission design service module RCS tank-sizing criteria are being reexamined; hardware modifications, alternate methods, and trade-offs are being investigated. The following are some of the studies in progress.

1. RCS quadrant failure criteria, mission success versus propellant requirements

2. Umbrella screens in the service propulsion subsystem (SPS) propellant tanks to reduce ullage maneuvers for SPS engine starts

3. Elimination of small ΔV maneuvers by various methods

4. Use of an additional service module aft-firing RCS engine supplied by the SPS propellant tanks for small ΔV maneuvers

5. Effects of using the manned space flight network (MSFN) as the primary navigation mode for the lunar-orbit phase as well as for the translunar phase

6. Review of the increased service module RCS propellant requirements versus passive temperature control effective temperature changes

The study of the effects of deleting the entry monitor subsystem (EMS) from Block I manned vehicles was completed. The ground rules for the study included a continuous recovery capability. The general Apollo single-failure criterion for subsystems was assumed for attitude reference subsystems. (This allows for the failure of only one subsystem in any pair of redundant subsystems.) Further, if a failed attitude reference subsystem could result in catastrophe, then the failed subsystem must be readily identifiable by the astronauts, or the mission and entry flight modes must be designed so that identification is unnecessary. The study considered normal entry velocities between 25, 500 feet per second and 29, 000 feet per second, and also included service module abort entries. Results indicate that positive lift must be maintained during such aborts in order to minimize aerodynamic loads. Also, during service module aborts, open-loop backup entry modes such as constant roll rate or constant attitude can be used, provided that adequate control information is available to the astronaut, and the primary guidance is restricted to positive-lift maneuvers. The investigation concluded that failure of an attitude reference subsystem could be detected at all times, and identification of this failure could be made only during a constant-attitude flight mode. However, the constant roll rate attitude is always available and does not require identification of the failed attitude reference subsystem.

Table 3, based on the foregoing considerations, indicates the entry ranging capabilities and the operational constraints imposed with the present Block I subsystems for manned flights.

Table 3. Acceptable Entry Backup Control Modes

Initial Entry Velocity	Entry Corridor Definition	Acceptable Backup Control Modes	Control Attitude Constraints	Ranging Capabilities
Under 26, 000 fps	Hybrid, positive lift overshoot with constant roll rate undershoot	Constant roll rate or constant attitude	Absolute angle of roll less than 90 degrees	Restricted closed-loop ranging
Under or over 26, 000 fps	Positive lift overshoot and undershoot	Constant attitude	Constant roll attitude	Uncontrolled entry ranging
	Ballistic	Constant roll rate	Constant roll rate	

A study was made of the effects of the possible addition of an attitude gyro and accelerometer with displays as a separate attitude reference subsystem. The addition of the gyro only would allow a dual attitude reference subsystem failure, and would facilitate identification of a single subsystem failure. This addition of the gyro only would also eliminate the need to switch back and forth between SCS and guidance and navigation (G&N) entry modes during a service module abort to identify subsystem failures. The addition of an accelerometer only would reduce RCS propellant requirements for possible backup orbit ejection. If both the gyro and the accelerometer with displays are added, the astronaut could fly an acceleration profile where conditions permit. However, no combination of these two instruments would remove existing entry corridor and mission constraints, nor would they remove the restriction for positive-lift G&N maneuver only. These constraints can be removed only when the capability exists for the astronauts to monitor critical safe-entry flight path limits. No additional hardware is required for entry trajectory monitoring or for manual backup entry trajectory control, provided that reduced mission flexibility and subsystem operation constraints are acceptable. The addition of a gyro and display would simplify subsystem failure detection and identification. The gyro would serve also as a reference for the critical task of lift-vector orientation. Thus, consideration should be given to the addition of an attitude gyro and display to Block I manned vehicles.

The initiation point for boilerplate 22 high-altitude abort was established. The abort should begin at an altitude of 108, 000 feet at Mach number 3. 7 and a dynamic pressure of 155 pounds per square foot. The test vehicle, including launch escape tower with canards, will be boosted by a Little Joe II at White Sands Missile Range (WSMR) in March. The command module will weigh 10, 000 pounds, and the launch escape vehicle will be ballasted to produce a center of gravity corresponding to that of the nominal control weight configuration at burnout.

CREW SYSTEMS

A study was conducted of recent requests to modify the optical alignment sighting assembly to be used in the command module. Results indicate that a second optical mount can be provided so that the device may be used at either of the two forward-viewing windows. Providing an in-flight capability, however, to adjust the line of sight (bore sighting) of the optical device with respect to the vehicle X-axis would increase the complexity of optical assembly and decrease reliability. A prototype of the optical aid was delivered to NASA-MSC; it will be transferred about January 1 to NASA-Langley for evaluation during full-scale docking studies.

The waste management subsystem is scheduled to undergo zero-g tests in the KC-135 flying laboratory in mid-December.

S&ID is preparing plans for an expanded support program for all zero-g tests aboard a KC-135 aircraft at Wright-Patterson AFB. The plan includes a mock-up of the complete command module to test various crew tasks and to verify envelopes of reach and vision under zero-g conditions. A separate mock-up of the command module and lunar excursion module tunnels, complete with probe and drogue, will permit tests of manual docking tasks. Extravehicular crew transfer via the command module side hatch will be tested also. A report to NASA on this proposed expanded support program will be completed during December.

[redacted]

Firm definition of the phase II manned centrifuge tests and responsibilities is expected to be achieved at the joint meeting of S&ID and NASA at Houston on December 18 and 19. This phase will provide dynamic simulation tests to verify the capability of the astronauts to perform required tasks in an Apollo Block I spacecraft under sustained acceleration.

Feasibility tests were begun on the emergency environmental cell for possible use onboard the Apollo command module. The cell would permit an astronaut egress from his pressure suit for personal hygiene reasons in the event the command module cabin pressurization failed.

STRUCTURAL DYNAMICS

An intensive effort has been undertaken to determine and eliminate the causes for the boilerplate 28 failure that occurred during the first water impact test. The effort includes close examination of the boilerplate 28 aft heat shield and aft bulkhead, static tests, tenth- and full-scale drop tests using various configurations of the aft heat shield, and design and analytical studies including computer programs.

Several analytical approaches are being investigated in support of the second boilerplate 28 water impact test. One of these is a digital computer program to analyze static hydroelastic failure. Loads imposed at water impact and the resultant deformations will be computed.

A long-range analytical study program has been proposed that would provide additional insight into the nature of flexible-shell impact. This program would be independent of the boilerplate 28 support program, and would not be expected to support early Block I vehicles.

A summary of tests conducted or planned in support of the second boilerplate 28 drop and the backup modal onset separation entry subsystem (MOSES) configuration are shown in Table 4.

The mainstream drop test effort consists of 200 drops of tenth-scale models and three series of drops using boilerplate 1. The 200 tenth-scale drops were made to test aft heat shields with various degrees of stiffness to determine the effects on vehicle acceleration at the instant of impact. The first series of boilerplate 1 drops, to simulate rigid aft heat shield structure, was completed and results are being analyzed. Vertical velocities were varied from 10 to 30 feet per second in 5-second increments. The second and third series of drops are intended to test varying degrees of aft heat shield stiffness. The former series employing an 0. 8-inch gap between aft bulkhead and shield was completed, and the latter series employing a 4. 0-inch gap is scheduled for completion in the latter half of December.

One hundred tenth-scale drop tests were completed using 14 variations of the MOSES backup configuration of the aft heat shield. Of the 14 MOSES configurations tested, one was selected and used in two drops of boilerplate 1. Results of the MOSES drops indicate that a peak g-load decrease of approximately 35 percent with a corresponding peak pressure decrease of over 50 percent can be obtained. Data reduction is continuing; preliminary conclusions, however, indicate that the water impact problem can be alleviated significantly by use of the MOSES configuration with a weight increase 25 to 90 pounds less than that for the mainstream reconfiguration now being incorporated in boilerplate 28.

Table 4. Mainstream and Backup Drop Tests in Support of the Boilerplate 28 Aft Heat Shield Study Program

Test Vehicle	Mainstream Effort for Second Boilerplate 28 Drop	MOSES Backup Effort
Tenth-scale model	200 drops completed of exist-spacecraft aft heat shield configuration with varying degrees of heat shield stiffness	100 drops completed of 14 different configurations
Boilerplate 1	Five drops completed with rigid aft heat shield	Two drops completed of one selected MOSES configuration
	Four drops completed with 0.8-inch gap between aft heat shield and aft bulkhead	
	Several drops planned for late December same as above but with 4.0-inch gap between aft heat shield and aft bulkhead	

STRUCTURES

As part of the overall test program, the command module aft heat shield was static-tested. Visual inspection and analysis of the test data showed that the specimen failed at 20 percent over the design limit load. The failure consisted of a buckle of the inner face sheet, just inboard of the bonded ring, at the attach bolt circle. The buckle extends approximately 250 degrees around the heat shield and is centered on the +Z axis. Further analysis of the test data is being conducted to determine the cause of the failure, and to study the effect of three subsequent applications of load.

The face sheet thickness and core density of the aft heat shield were determined for the second drop of boilerplate 28. The heat shield design will be the same as the present configuration for spacecraft 009, the unmanned suborbital test vehicle.

The spherical design of the aft heat shield is being analyzed by a digital computer program to determine internal load distribution. The design criteria being used are that no general instability failure shall occur when the aft heat shield is subjected to a 200-psi spike loading over a 20-inch diameter circle or a 70-psi loading over a 78-inch diameter circle. The minimum impact angle for either case is assumed to be 15 degrees. These criteria are subject to change when the results of hydroelastic and Monte Carlo (probability) analyses are received.

Inspection of the boilerplate 28 aft heat shield after the first drop disclosed several areas of peel failure that appear to indicate poor bond. However, specimens cut from the damaged heat shield, subjected to block shear and beam tests, successfully sustained core and facing stresses greater than design limits.

The inner structure of spacecraft 009 was successfully subjected to an internal proof pressure of 9.5 psi in conformance with the manufacturing acceptance test plan. No structural discrepancies were observable after depressurization.

The lubrication test of the hinge gear box of the astrosextant door mechanism was successfully completed. Tests were conducted on two hinge drive-gear boxes to verify the design and to evaluate lubrication (Versilube G-300 grease plus dry film) at low temperature (-100 F), normal operating torque (10 inch-pounds in a space environment or 75 inch-pounds in a ground environment), and emergency torque (400 inch-pounds). Approximately 1030 test cycles were conducted.

Two SPS production fuel tanks were received from the Allison Division of General Motors. With the delivery of these two production tanks, Allison has satisfactorily completed its contract for SPS fuel and oxidizer tanks for spacecraft 001, 006, 008, 009, and 011.

FLIGHT CONTROL SUBSYSTEM

Guidance and Control

The Block II procurement specification for the SCS was completed. A plan of action for the review and refinement of the Block II G&N performance and interface specification is being prepared for NASA review on January 20.

A design study of the Block II EMS was completed for a hybrid analog-digital EMS circuit configuration. The investigation shows that the hybrid circuit provides optimum mechanization with significant savings in weight and volume compared to a straight analog EMS circuit configuration.

The computerized engineering breadboard tests of the EMS plotter display and associated driver equipment were completed. Results indicate that the display window can be reduced in size from the present 4-inch by 5-inch size to 3 inches square if necessary to meet display panel space requirements. In addition, the g scale on the display pattern can be reduced; changes can be incorporated without affecting operator performance.

Qualification testing of all SCS hardware to support spacecraft 009 and 011 will be completed at Honeywell by the end of December.

Flight Subsystem Analysis

An intensive engineering effort is being undertaken to implement the combined subsystem dynamic verifier (CSDV) to be used in support of the simulation program. Detailed hardware and software requirements are being formulated. Initially, the CSDV will be used to verify the spacecraft 009 SCS hardware and the SPS gimbal hardware. Later, the total G&N subsystem (AGE-6) and the flight table will be incorporated into the CSDV.

The integrated S&ID and Honeywell simulation program plan for Block I and Block II should be completed during the next report period. Detailed plans were completed for Block I and Block II studies to be made by S&ID during 1965 and 1966. The Block I Honeywell effort was completed except for system verification testing (SVT). Final Honeywell SVT and Block II plans are being formulated.

Automated Control

The specification control drawing and the procurement specification for the spacecraft 009 control programmer were completed. A design change was initiated to incorporate the 0.05-g backup sensor switches in the spacecraft 009 control programmer. Detailed sequencing was determined for the spacecraft 009 vehicle recovery aids at touchdown, including deployment of the HF antenna, transmitter power switching, and inflation of the uprighting bags.

TELECOMMUNICATION

Communications

The signal generator for the C-band bench maintenance equipment (BME) was repaired and returned to S&ID. Checkout of C-band BME was initiated; however, a voltage transformer is required to maintain the required line voltage.

Agreement was reached between S&ID and Grumman on the techniques to be employed to develop effective VHF polarization between the command-service module and the lunar excursion module.

Two engineering evaluation models of the HF orbital antenna, primarily for use in deep space, will be fabricated by DeHavilland Ltd., Ontario, Canada. The antenna will be deployable, and will be lost at the time of separation of the command and service modules. The astronauts can then switch to the HF recovery antenna. The HF orbital antenna will be incorporated on spacecraft 012 and subsequent Block I manned spacecraft.

A joint communication subsystem meeting of S&ID, NASA, and Grumman was held at MSC on November 17 and 18. The status of commonality between communication equipment of the command-service module and the lunar excursion module was discussed. Subtier contractors also participated. Functional, environmental, and detailed electrical and mechanical differences between the following corresponding equipment of the two space vehicles were identified:

Unified S-band
S-band power amplifier
Premodulation processor
Audio center
VHF/AM antennas
VHF multiplexer

Changes required to eliminate these differences and the impact of such changes were identified. Equipment that differed least in functional and performance requirements included the VHF/AM and the VHF multiplexer. NASA will initiate follow-up action to produce required commonality between corresponding equipment of the two vehicles.

<u>Instrumentation</u>

A total of 87 specification control drawings (SCD) and supporting procurement specifications for instrumentation sensors have been released to date. Each SCD defines and controls a unique instrumentation sensor available in various ranges. Qualification tests were completed for the hardware represented by 19 of these SCD's; qualification testing of the remaining hardware is in progress.

A contract for the production of the nuclear particle detection subsystem was placed with Philco Western Development Laboratories, Palo Alto. The design, development, and delivery of engineering models is scheduled for completion in mid-June.

ENVIRONMENT CONTROL

Corrosion-prevention studies of the environmental control subsystem (ECS) were continued. Experiments show that internal corrosion occurs in the coldplates in the presence of electrical current induced by an external source imposed across the coldplates. Studies also show that an electrical current can be produced in the coldplates by the combination of dissimilar metal couplings. More than 2 volts may be generated at epoxy joints in the coldplates that are grounded to electronic boxes; grounding strips are being considered as a possible solution to this problem. Investigation shows that corrosion can be stopped by an inhibitor even when the corrosion has been intentionally initiated. Once stopped, the application of from 4 to 5 volts is required across specimen probes to reinitiate the corrosion action. The inhibitor protected against corrosion even when couplings of very dissimilar metals were subjected to approximately 2 volts.

The present configuration of the Block II ECS space radiator incorporates one three-tube panel and one five-tube panel. The latter panel provides clearance in sector II for the adjacent oxidizer tank. The combined radiator area of the two panels is approximately 130 square feet.

The ECS radiator panel limits the number of days for Block I earth orbital missions. Test panels are being fabricated on an expedited basis in order to determine the degree of maldistribution in panel flow. These data are needed to predict more accurately the maximum number of days possible for Block I earth orbital missions.

Transient-case temperature studies of the command module interior were made for ten earth orbits with the command module oriented toward the sun. By the end of the tenth orbit, the cabin air temperature neared 82 F; there were no condensation points (areas where the temperature within the cabin fell below 70 F). Ablator bondline tables are being prepared for transient-case temperatures for ten earth orbits with the service module oriented toward the sun.

Thermal performance tests were conducted on the pin-fin[1] coldplate for the new design of the Apollo guidance computer (AGC). Heater plates constructed per MIT's thermal map were used in tests conducted at sea-level and at 1×10^{-4} Torr conditions. The maximum AGC base temperature observed was 90 F using the spacecraft coolant subsystem flow rate (40 pounds per hour at 70 F inlet temperature). The maximum allowable temperature specified by MIT is 105 F.

[1]Pins inside the passages of the coldplate produce turbulence to aid in heat transfer.

Evaluation of the maximum radiation flux rates encountered during an elliptical orbit of an Apollo spacecraft through the earth's radiation belts was completed. The usefulness of the nuclear particle detection subsystem (NPDS) for measuring the belts of proton flux was confirmed. With the exception of high flux rates (15 million electron volts), the present NPDS design is adequate for measuring solar-flare flux without major modification.

Command module aerodynamic heating rates and maximum heat load were defined for a spacecraft 009 entry at 20 g's in support of the current heat shield design verification effort. The maximum (convective and radiative) unperturbed heating rate obtained is 336 Btu per square foot per second with a corresponding maximum heat load of 12,251 Btu per square foot. Aerodynamic heating rates were defined also for a Block I extended-time entry trajectory (1490 seconds from an altitude of 400,000 feet to 25,000 feet). The maximum predicted heating rate and heat load are, respectively, 90.24 Btu per square foot per second and 28,686 Btu per square foot.

ELECTRICAL POWER

The engineering model of the hydrogen tank for the cryogenic gas storage subsystem (CGSS) successfully passed the resonant survey and design-proof vibration tests. The tank was filled with hydrogen at operating pressure (240 psig), and was tested in all three axes. All tank components, including heater, fan, pressure switches, and temperature sensors, functioned within specification limits during the tests. The engineering model of the CGSS oxygen tank successfully completed the 30-hour standby heat leak test; other tests are in process. Beech Aircraft, supplier of the CGSS hydrogen and oxygen pressure vessels, is conducting the tests. About 75 percent of the CGSS engineering development test program, including vibration testing of the oxygen tanks, is to be completed by the end of December.

Qualification testing of the motor switch for control of the inverter output was completed; S&ID is reviewing the test reports submitted by Kinetics Corp.

A Westinghouse inverter was supplied to Honeywell for use in the EMI tests of the SCS; no incompatibilities were revealed. Acoustic noise generated by the inverter and other equipment in the command module will be analyzed using boilerplate 14.

All pyro batteries required for boilerplates 14 and 22 were delivered by Electric Storage Battery Co., Raleigh, North Carolina.

Eagle-Picher completed qualification testing of the 25-ampere-hour entry and postlanding battery; two qualified batteries are scheduled for delivery in February.

The package sizes for Block II SCS and telecommunication equipment were determined. Control drawings were completed, defining size, shape, and interface details. These control drawings are being used in support of mock-up fabrication.

PROPULSION

Service Propulsion Subsystem (SPS)

Sixty-seven injector firings were conducted in the dynamic stability test program. Sixteen injector firings were conducted on the recently activated E-6 test stand at Aerojet-General, Sacramento. Twenty-two engine firings were accomplished on three engine assemblies having unbaffled injectors. Table 5 lists all firings conducted at Aerojet during the report period.

The spacecraft 001 helium pressurization panel and propellant tank subsystem were subjected to initial proof-pressure and leak tests. Helium leakage from the 3-inch roll-swage joints in the transfer line between oxidizer tanks was so slight that no liquid leakage would have resulted. However, the cause of the leakage and a solution of the problem are being studied.

The first gimbal tests were performed on boilerplate 14 in preparation for engine gimballing on test fixture F-2. Frequency, ramp, and step response tests were performed.

SPS testing on the F-2 test fixture at WSMR is continuing at a satisfactory rate. The first series of SPS engine tests on the F-2 fixture at WSMR was completed. Test-run firing duration varied from 10 to 100 seconds with two engine restarts being performed. Total time of the runs on the F-2 fixture was 430 seconds; the SPS performed satisfactorily in all cases. The helium pressurization and instrumentation subsystems of the F-2 test fixture are being modified in preparation for the second series of SPS tests. Most operational problems have been resolved, although data acquisition and flow meter calibration have not yet been perfected sufficiently to meet test program objectives. Table 6 summarizes the tests conducted during this report period.

Reaction Control Subsystem (RCS)

One of three service module RCS engines completed the hot-firing operational sequence required for the preliminary flight-rating test program being conducted at Marquardt. The other two engines are undergoing acceptance tests.

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Table 5. Apollo SPS Engine Development at Aerojet

Serial No.	Pattern Type	Type of Evaluation	Ablative Chamber No. of Firings	Ablative Chamber Time (sec)	Steel Chamber No. of Firings	Steel Chamber Time (sec)	Engine No. of Firings	Engine Time (sec)	Test Conditions and Results
0034	POUL-41-56	C*			5	28			Satisfactory
		Steady state	6	61					Satisfactory
	POUL-41-44	C*			4	21			Combustion stability monitor shutdown on last firing
0054	POUL-41-26	C*			3	17			Satisfactory
		Mission	13	290					Injector burn-through at P_c tap
0039	POUL-41-43	TCA evaluation	3	689					Chamber separated at injector flange
		C* & pulse			4	21			Satisfactory
		Mission	13	268					Popping noted
0050	POUL-41-38	C*			4	22			Satisfactory
		Mission	12	156					Popping noted during last firing
AFF-72	POUL-31-10	C*			16	85			E-6 test stand activation
AFF-68	POUL-31-37	Acceptance			3	16			600-cps oscillation
Engine assembly 010	AFF-64	Balance					2	11	Satisfactory
		Acceptance					8	46	Satisfactory
Engine assembly 017	AFF-35	Balance					1	5	Satisfactory
Engine assembly 007	AFF-54	Checkout					11	47	Combustion stability monitor shutdown on last firing. Cracked fuel injector manifold feed line. Loose upper pitch actuator bracket.

C* = characteristic exhaust velocity

TCA = thrust chamber assembly

Table 6. Summary of SPS Engine Testing on F-2 Fixture at WSMR

Test	Duration of Firing (sec)	Percent of Propellant in Tanks at Start	Test Conditions and Results
6	20 to 100	60 initially	The first start was shut down by the vibration safety cutoff. The subsequent starts and crossover transient were satisfactory.
7	10 (repeated 8 times)	95 to 60 (in 5 percent increments)	The first start was again shut down by the vibration safety cutoff. All subsequent runs were successful.
8	20	40	This run was performed to determine the effect of bleeding all lines connected to the propellant distribution subsystem prior to engine start. The test result was satisfactory.

The boilerplate 14 sensors and display unit for the propellant quantity gauging subsystem of the service module RCS were installed in the vehicle. The subsystem computer will be installed following checkout of the gauging subsystem wiring.

A model to simulate the pneumatic portion of the command module RCS is being fabricated by the supplier of the command and service module RCS pressure regulators. The simulated RCS model will be used to study any interaction that may occur between parallel regulators during operation in the RCS. The tests will also determine whether regulator response to the actuation of the explosive valve creates pressure spikes downstream that are unacceptable.

Launch Escape Subsystem (LES)

A tower jettison motor was successfully static tested in the qualification test program on December 3 at Thiokol. Two initiators fired the motor under vacuum conditions with grain temperature at 70 F. Preliminary data show that the maximum pressure was 1381 psia, and the resultant thrust-vector angle was 3.62 degrees. The test results were within specification limits.

Propulsion Analysis

The proposed engine heater for the service module RCS may require relocation as a result of new data (engine thermal properties of a wider range) furnished by Marquardt. These new data consist of changes in engine valve thermal resistance and valve temperature gradients, and temperature limits. Alternate RCS heater locations being considered are the injector head and the inner housing.

Analysis was performed on the manifolding design of the pressure transducer for the SPS engine injector head, submitted by Arnold Engineering Development Center (AEDC). The AEDC design provides adequate response to SPS engine thrust transients.

Rocketdyne submitted an analytical program for qualifying the nozzle extension of the command module RCS engine. The program consists of experimental determination of thermophysical properties and a computer program for two-dimensional thermal analysis of ablator charring.

Five more flights were made in the KC-135 flying laboratory at Wright-Patterson AFB to determine propellant behavior under zero-g conditions. This group of flights completed phase A of the tests to obtain data relative to screen and baffle retention of propellant. Propellant motions resulting from SPS engine shutdown and RCS maneuvers were simulated. Testing included retention screens with varying hole size and various open areas. The propellant motion characteristics were thus determined within a range of varying conditions. The selected retention screen hold size and percent of open area were verified in the tests. Propellant was retained satisfactorily, and sloshing did not exceed acceptable limits.

GROUND SUPPORT EQUIPMENT (GSE)

GSE Checkout Subsystems

The ACE activation in building 290 to support the boilerplate 14 phase II (integrated) testing was completed on schedule, including the ACE carry-on subsystem. The first successful run of the boilerplate 14 integrated subsystem test using the ACE command and monitoring units was completed on December 1. The ACE digital test command subsystem (DTCS) was reviewed for the purpose of adopting the subsystem to the spacecraft applications required for each specific mission.

Table 7 shows GSE models completed and delivered:

Table 7. GSE Models Completed

Using Location	Applicable Vehicle	GSE Model
S&ID, Downey	Boilerplate 14	GSE verification unit* Command module substitute Adapter-launch vehicle substitute Fuel cell heater supply*
	Boilerplate 22	Launch vehicle substitute unit Test conductor console (modification kit)
	Spacecraft 009	Pyrotechnic initiator substitute unit
WSMR	Spacecraft 001	SPS checkout and firing control Electrical power subsystem checkout unit
		Fluid distribution subsystem control units: Service module RCS fuel RCS oxidizer Helium Liquid hydrogen Liquid oxygen SPS oxidizer SPS fuel
	Test fixture F-2	SPS checkout and firing control

*These units are being modified for use with spacecraft 009 also.

GSE Service Subsystems

Subsystem 1 of the spacecraft instrumentation test equipment (SITE), to be used in support of boilerplate 14, is being updated. Thus far, all spacecraft tapes have been checked out using SITE without flight equipment in the loop, except the tapes for the spacecraft pulse code modulation (PCM) subsystem, which were checked against boilerplate 14 equipment. Sixty percent of the tests on the tapes have been completed.

Honeywell completed manufacture of the first unit of SCS bench maintenance equipment (BME) to be used in support of spacecraft testing. All acceptance tests were completed except checkout of the control amplifier for the display and attitude gyro accelerometers.

The system checkout of the polarity checker unit in building 290, Downey, was completed, and functional testing under load was begun. (See Figure 5.) This equipment tilts and rolls the mated command and service modules to simulate spacecraft yaw, pitch, and roll and verifies the correctness of RCS and SPS engine responses to signals generated by the guidance and control attitude sensors.

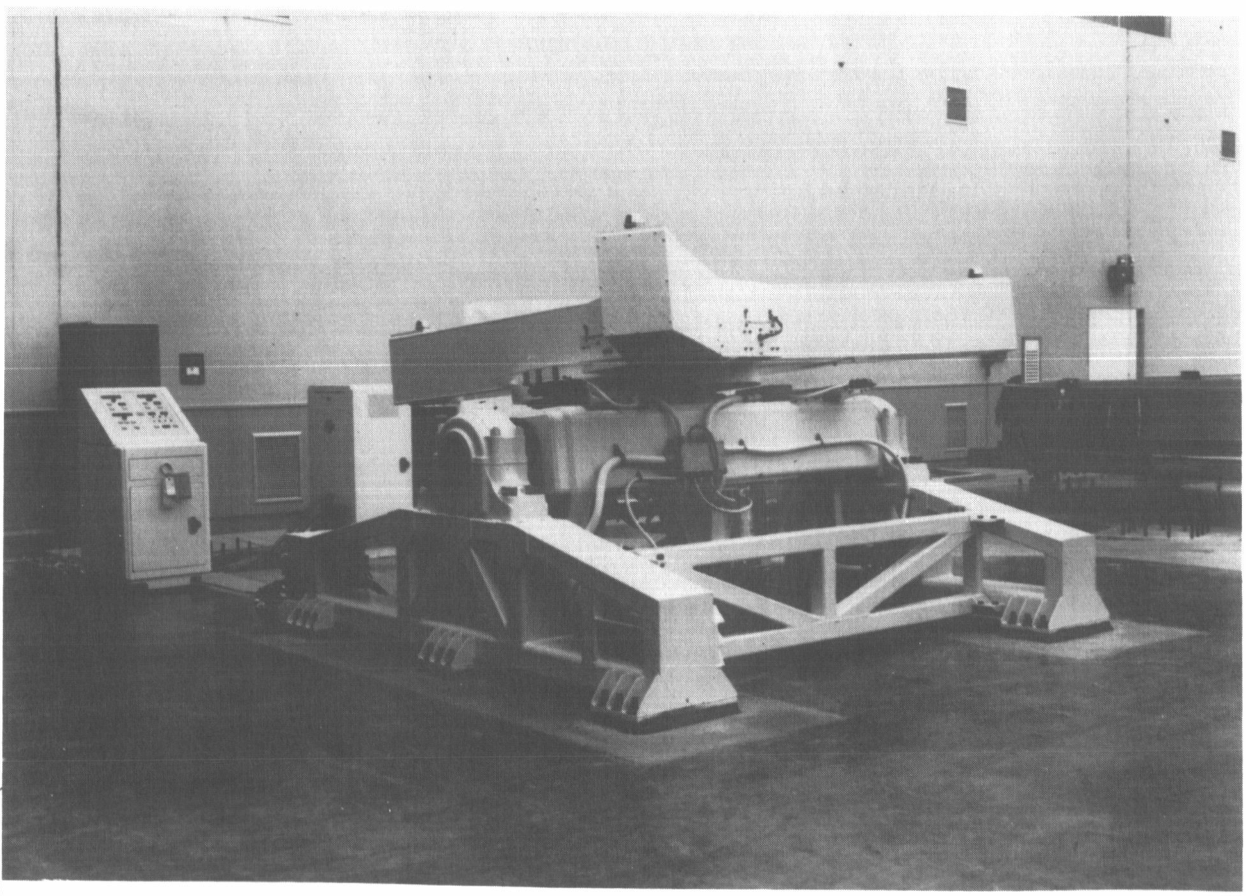

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Figure 5. Polarity Checker, Control Console and Support Base

The following GSE service models were delivered during this report period for use at S&ID, Downey:

Number	Model
A14-048	Earth landing subsystem weight and balance set
C14-141	S-band receiver
S14-003	Helium leak tester
S14-009-0001	Helium transfer unit
S14-022-0002	Helium booster unit
S14-058	Fuel ready storage unit
S14-059	Oxidizer ready storage unit
S14-060	Fuel toxic vapor disposal unit
S14-061	Oxidizer toxic vapor disposal unit

SIMULATION AND TRAINERS

The evaluator 1 command module is being structurally modified to spacecraft 012 configuration to permit installation of full main and lower control and display panels with live equipment to be tied in with the computer complex.

The SCS mode selector switching and circuit breakers for evaluator 2 were modified for the entry 3 analog study. Also, the translational hand controller was altered to provide a 30-degree tilt. This study was completed December 3, and consisted of 352 production runs employing a man in the loop; one NASA subject and two S&ID subjects participated. The purpose of the tests was to investigate preentry orientation and checkout procedures for SCS and RCS. Twenty-two various G&N failure modes were inserted during the runs, none of which resulted in loss of vehicle or IMU gimbal lock. The study covered preentry flight for the period following separation of command and service modules until the latter reaches 0.05 g. Results indicate that this flight phase is accomplished with an average consumption of command module RCS propellant of approximately 5 pounds. Recommendations for checkout and orientation procedures for the preentry flight phase have been made on the basis of these results.

Acceptance tests of all real-time simulation subsystem hardware, except the linkage control console, were begun at Scientific Data System, Santa Monica, California. Delivery of the equipment is scheduled for late December; the related software will be completed by the same subcontractor in late January.

The functional test of the SCS for the CSDV of spacecraft 009 was completed, following functional modification of the Honeywell prototype SCS. The following equipment for the mission evaluation study of spacecraft 009 was developed and fabricated: the RCS delay circuit for the command module jets, the logic circuits and accumulators for the fuel accounting subsystem, and the analog-to-frequency converters.

The ECS, EPS, and SCS trainers were shipped to NASA-MSC on December 4 following successful completion of acceptance tests. The remaining two trainers, propulsion and sequential flow, are scheduled for acceptance tests early next year to permit shipment to NASA-MSC by mid-January.

VEHICLE TESTING

Manufacture of boilerplate 22 is nearly complete, and preparations are being made for a DEI to be held by NASA on December 18. Power-on tests will begin in January.

A boilerplate 23 postflight study of motion pictures reveals that the Teflon window for the telemetry antenna was lost just prior to jettison of the boost protective cover. The window is being redesigned to provide an edge member for positive attachment to the boost protective cover.

Of the 127 measurements required in the boilerplate 23 flight, 96 percent provided good data for use in design analysis. The service module camera and four transducers failed, resulting in loss of one command module static pressure measurement and three fluctuating pressure measurements (two in the command module and one in the service module). The acquisition of boilerplate 23 data was accomplished by use of an onboard tape recorder and a telemetry subsystem. The tape recorder had 14 tracks, and the telemetry subsystem provided 45 continuous and 88 commutated channels.

Modification of boilerplate 14 is expected to be completed in early February in support of spacecraft 009. Sequencers, including the mission sequencer, and associated harnesses are being installed.

The fabrication of boilerplate 29 is proceeding on schedule for delivery in late February.

Functional checkout of spacecraft 001 (service module) was completed except for the RCS panels and the SPS helium panel. Completion of checkout is expected to support shipment of the vehicle to WSMR by December 17.

All major subassemblies of the internal secondary structure of the spacecraft 006 command module were completed and fit-checked. Bonding and installation of the secondary command module structure are in process; subsystem installation will follow in building 290.

RELIABILITY

The Block I PCM telemetry has been subjected to all environments of an Apollo spacecraft mission profile, failing only in the area of humidity. A mechanical redesign mock-up was completed, including the use of a desiccant and inlet and outlet valves to control humidity. With the mock-up, qualification test levels were met successfully, and a final design review of this modification was completed. In an effort to meet schedules, Block I PCM end-item manufacture is proceeding with this calculated risk.

The present Westinghouse static inverter configuration will be subjected to minimum airworthiness tests (MAT) to qualify the hardware for spacecraft 009 and 011 (unmanned missions). This plan allocates two units for MAT starting in March. A parallel effort of a redesigned configuration will begin immediately to reduce noise generated by the octadic transformer and to reduce electromagnetic interference by the rearrangement of some static inverter components. The reconfigured units will be used on spacecraft 012 (manned) and subsequent Block I vehicles.

A reliability assessment was performed on the tower jettison motor, based on the development program data furnished by Thiokol. The reliability assessment evaluated the performance parameters of the motor, and assessed the total performance of the motor by combining the reliability values of individual parameters. The study indicates the probability that the motor will meet its required objectives with no single performance parameter contributing significantly to unreliability.

Hot firing of the command module RCS for early unmanned vehicles (spacecraft 009 and 011) would aid in verification of checkout procedures. If only one half of the redundant RCS subsystem is ground-checked by hot firing, the effects of such operations could be evaluated separately. Different sequences of operations during flight could then be performed by the alternate halves of the subsystem. Modifications in design or test procedures would be required to allow bypassing of helium isolation squib valves and fuel burst diaphragms, so that these items would not require replacement before flight operations. Additionally, automatic switchover would be required in case of failures in either subsystem during the sequential operation.

BLOCK II HIGHLIGHTS

Full Block II go-ahead was received from NASA for design, fabrication, and procurement.

A meeting was held December 14 and 15 between S&ID and NASA to discuss the status and to determine the disposition of the requests for change (RFC's) generated at the design engineering inspection (DEI) of the preliminary Block II mock-up held on October 1. NASA is considering a follow-up DEI to evaluate the implementation of these RFC's.

Detailed Block II mock-up specifications were completed for the lower equipment bay and the forward compartment of the command module in preparation for a Block II mock-up DEI proposed for late February. A preliminary DEI of the mock-up drawings is planned for early January.

OPERATIONS

DOWNEY

Boilerplate 14

The acceptance checkout equipment (ACE) carry-on equipment platforms and inverter 3 were installed in boilerplate 14 on November 16. The debugging of the uplink tape was completed and verified by accomplishing two good runs with the tape. The boilerplate 14 integrated system checkout was initiated on November 22 and was completed satisfactorily on December 1.

The service propulsion engine gimbal stability checkout was satisfactorily completed on December 8. A modification period was begun during which the crew couches, ACE carry-on equipment, main display and control panels, and electronic packages for the communication and instrumentation subsystem and the stabilization and control subsystem were removed for modification of equipment and vehicle wiring.

During the next report period, vehicle modifications will be performed. The sequencer harnesses, control boxes, and display panels for sequencer operation checkout will be installed. Thermocouples will be installed on the coldplates to obtain temperature profiles.

Spacecraft 001

The GSE-SMD integrated checkout was completed, and all GSE-SMD cables were then connected to the spacecraft. Electrical function checkout of the electrical power subsystem (EPS) and the service propulsion subsystem (SPS) was completed on November 21, and the instrumentation checkout was completed on November 25.

Spacecraft 001 was moved to building 260 on November 28 for pressure testing of the SPS and the cryogenic storage subsystem. The SPS proof pressure and leak tests and the cryogenic storage subsystem pneumatic, instrumentation, and electrical checkouts were accomplished. Spacecraft 001 was returned to Building 290 to replace the leaking tank cover seal and to repair the leaking B nuts; a subsequent SPS pressurization and leak check was completed satisfactorily on December 11.

The oxidizer probe was installed on December 12. The malfunctioning pressure regulators were replaced on the helium pressurization panel on December 13, and panel installation is in progress.

During the next report period, all mission readiness testing will be completed. Spacecraft 001 will be prepared and shipped to WSMR on December 17.

Boilerplate 22

The preparation and publication of operational checkout procedures for boilerplate 22 will be continued during the next report period. The horizontal weight and balance check of the command module will be completed, and the vehicle will be stacked. Individual system checkout will be started.

Spacecraft 009

The preparation and publication of operational checkout procedures will be continued during the next report period. The uplink and downlink tape verification for spacecraft 009 will be accomplished using acceptance checkout equipment station 2.

WHITE SANDS MISSILE RANGE

Propulsion System Development Facility

Three test operations were conducted using service propulsion engine 0006 installed in test fixture F-2 to complete test series 1. These tests continued the investigation of the low mixture ratio or high fuel flow. Data obtained during these three tests agreed closely with data obtained from earlier tests. The investigation of the low mixture ratio will be continued during test series 2. The original test objectives, deferred to permit investigation of the low mixture ratio, will be rescheduled.

Detanking of the fuel and oxidizer from test fixture F-2 was accomplished, and engine 0006 was removed. Updating of the test fixture 2 and the GSE was begun in preparation for the next test series (to be conducted on engine 0010).

Mission Abort

Preparations for the launch of boilerplate 23 were continued. Integrated system test 1 was completed on November 25. The simulated countdown was completed satisfactorily on December 3, and the flight readiness review meeting was held on December 4. The precountdown operations were completed on December 6, and the command and service modules were closed out for flight.

Boilerplate 23 was successfully launched at 8:00 a.m. (MST) on December 8. The test was conducted to demonstrate satisfactory launch escape vehicle performance utilizing the canard subsystem and boost protective cover, and to verify the abort capability in the maximum dynamic pressure region with conditions approximating emergency detection subsystem limits. The entire operation from countdown through recovery was considered highly successful. The canard subsystem actuation appeared normal, and launch escape vehicle turnaround to the blunt-end-forward orientation was achieved after several tumbles of the vehicle. The boost protective cover was successfully jettisoned with the escape tower. The earth landing subsystem successfully lowered the command module to the ground (see Figure 6). Postflight hardware evaluation and data analysis are being accomplished. Recovery operations are continuing to recover portions of the soft boost protective cover.

During the next report period, GSE for boilerplate 23 will be prepared and shipped to Downey. The test facility will be modified to support boilerplate 22 operations, and GSE for boilerplate 22 will be received and inspected. The WSMR operational plan, revised standard operating procedures, operational checkout procedures, and detailed and integrated schedules will be prepared.

Test Fixture F-2

Modification and preparation of test fixture F-2 will be accomplished during the next report period. The engine bird cage will be modified to

Figure 6. Boilerplate 23 Command Module After Earth Landing.

accept a gimballed engine, the flame shield will be installed, the helium pressurization package will be replaced, all transducers will be recalibrated, engine transducers will be installed, the flowmeters and propellant feed lines will be calibrated, engine installation leak and functional checks will be completed, and a prerun setup will be performed for the first test in the second series of F-2 firings.

Spacecraft 001

Effort will be directed during the next report period for preparation of the test stand for spacecraft 001 and checkout of the service module in the test stand for subsequent spacecraft testing. The initial activity will be the installation, integration, and validation of the associated GSE. After receipt, inspection, and subsequent checkout of the module, it will be installed in the test stand. The GSE will be mated to the spacecraft, and integrated GSE-spacecraft system functional checkout will be started.

FLORIDA FACILITY

Boilerplate 16

The command module-service module fit check was completed on November 23. Replacement of the tower jettison motor interstage assemblies was completed. Verification of the command module-service module mating procedure was accomplished in hangar AF on November 30. The command module was then turned over to NASA-KSC for installation of relay boxes and wiring checkout.

During the next report period, checkout operations for boilerplate 16 will continue in accord with the Florida facility operations schedule. The launch escape subsystem buildup will be completed on January 8. The command module will be mated to the launch vehicle on January 13.

Spacecraft Planning

The preliminary Florida facility test operations requirements document for spacecraft 009 will be reviewed and published in January 1965. The "Spacecraft 009 Operations Plan" will be published by December 31, 1964.

ACE-Spacecraft Support

ACE breadboard support will continue for both NAA and NASA ACE-SC hardware-oriented problems. Particular emphasis will be placed on the monitoring of NASA-GE ACE ground station activation, verifying boilerplate 14 and spacecraft 009 tapes in support of Downey checkout operations, and establishing the operational checkout procedure format with the use of ACE.

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FACILITIES

DOWNEY

Display and Design Engineering Inspection, Phase II

The construction contract was awarded on November 25, and construction was started on December 14.

Quality Verification Vibration Testing (QVVT)

The purchase order for the procurement of the basic QVVT subsystem was issued to Ling Electronics on December 4, 1964. Ling submitted an 11-week delivery schedule, including a preliminary checkout of the combined subsystem at the Ling plant. The QVVT subsystem is scheduled to be shipped to S&ID by February 22, 1965, supporting the schedule of spacecraft 006.

Monitoring and Controlling Subsystem

The rough-draft procurement specification has been completed for the QVVT monitoring and controlling subsystem for use on deliverable spacecraft. Initial tests on spacecraft 006 will be run with borrowed monitoring equipment from the space system development facility.

Spacecraft 009 Checkout Station 7C, Building 290

Initial construction work for cable trays and supports was started on December 7. This is the first major step toward the activation of station 7C in building 290.

Building 290 Addition

The utility tunnel walls are in place, and a casting bed has been prepared for the tilt-up concrete wall panels. Basement and pit excavation is essentially complete, and underground utilities and ground cables are being installed. The project is approximately 12 percent complete.

Building 341, Compton

The west side construction modifications were completed; GSE-SMD manufacturing was moved during the weekend of December 11.

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APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID Schedule of Apollo Meetings and Trips
November 16 to December 15, 1964

Subject	Location	Date	S&ID Representatives	Organization
Technical progress evaluation meeting	Sacramento, California	Nov. 16	Mower	S&ID, Aerojet
Radiator test breadboard	Grand Prairie, Texas	Nov. 16 to 17	Jay	S&ID, Ling-Temco-Vought
Product improvement program meeting	Houston, Texas	Nov. 16 to 18	Sweet, Hitchens	S&ID, NASA
Engineering coordination meeting	Houston, Texas	Nov. 16 to 18	Webster, Hall, Kronsberg, White, Whitehead, Tyner	S&ID, NASA
Guidance and control subpanel meeting	Huntsville, Alabama	Nov. 16 to 19	Kennedy, Silogyi, Hogan, Nowak	S&ID, NASA
Working level meeting	Windsor Locks, Connecticut	Nov. 16 to 20	Dziedziula, Kolody	S&ID, Hamilton-Standard
Engineering coordination meeting	Bethpage, L. I., New York	Nov. 16 to 20	Gardner	S&ID, Grumman
Technical problems, discussion	Urbana, Ohio	Nov. 16 to 20	Hulley, Champaign	S&ID, Grimes
Design review meeting	Melbourne, Florida	Nov. 16 to 25	Dorrell	S&ID, Radiation
Overall mission implications, discussion	Houston, Texas	Nov. 17 to 18	Steverson, Peterson, Seeger, Morris	S&ID, NASA
VHF recovery beacon design review and discussion	Cedar Rapids, Iowa	Nov. 17 to 18	Murufas	S&ID, Collins
Aft heat shield status review	Middletown, Ohio	Nov. 17 to 20	Smith	S&ID, Aeronca
Apollo test data working group meeting	Daytona Beach, Florida	Nov. 17 to 21	Rutkowski, Gianformaggio	S&ID, General Electric
Inverter design status and scheduling review	Lima, Ohio	Nov. 18 to 20	Champaign, Hulley	S&ID, Westinghouse
Flight technology meeting	Houston, Texas	Nov. 18 to 20	Gillie, Alexander	S&ID, NASA
Program review	Lowell, Massachusetts	Nov. 18 to 20	Eberhardt	S&ID, Avco
Program status review	Binghamton, New York	Nov. 18 to 20	Mihelich	S&ID, General Precision
General range safety plan meeting	Houston, Texas	Nov. 18 to 20	Lewotsky, Updegraff	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
November 16 to December 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Heat shield material ablation tests, observation	Mountain View, California	Nov. 18 to 20	Nusenow, Monda	S&ID, NASA
Pneumatic valve program plan review	Sacramento, California	Nov. 19 to 20	Cadwell	S&ID, Aerojet
Management review meeting	Houston, Texas	Nov. 19 to 20	Ryker, McCarthy, Cooper	S&ID, NASA
Rough stress analysis coordination	Houston, Texas	Nov. 19 to 20	Stuart	S&ID, NASA
Fabrication evaluation	Virgennes, Vermont	Nov. 19 to 26	McKellar	S&ID, Simmonds
Engineering coordination	Houston, Texas	Nov. 20 to 21	Treman	S&ID, NASA
Inverter program meeting	Lima, Ohio	Nov. 21 to 24	Castle	S&ID, Westinghouse
Preflight readiness review board meeting	Houston, Texas	Nov. 22 to 23	Lish	S&ID, NASA
Design review meeting	Santa Clara, California	Nov. 23 to 24	Harcourt, Lee	S&ID, Explosive Technology
Quality control review	Cleveland, Ohio	Nov. 22 to 24	Nash, Orr, Brandt	S&ID, Clevite
Procurement specification review	College Park, Maryland	Nov. 22 to 25	Rumsey	S&ID, Emertron
System design verification meeting	Houston, Texas	Nov. 22 to 25	Dacus	S&ID, NASA
Total system performance meeting	Minneapolis, Minnesota	Nov. 23 to 24	Wong	S&ID, Honeywell
Panel coordination meeting	Houston, Texas	Nov. 23 to 24	Milliken, White, Tooley	S&ID, NASA
Technical review meeting	Houston, Texas	Nov. 23 to 24	Madden	S&ID, NASA
Management review meeting	Sacramento, California	Nov. 24	Feltz	S&ID, Aerojet
Program status review	Sacramento, California	Nov. 24	Field	S&ID, Aerojet
Engineering technical review	Santa Clara, California	Nov. 24	Lee	S&ID, Explosive Technology
Technical and administrative coordination meeting	Sacramento, California	Nov. 24	Bellamy	S&ID, Aerojet

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S&ID Schedule of Apollo Meetings and Trips
November 16 to December 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Engineering coordination meeting	Cedar Rapids, Iowa	Nov. 29 to Dec. 4	Shields, Kircher	S&ID, Collins
Monthly program status review	Minneapolis, Minnesota	Nov. 29 to Dec. 1	Wallace	S&ID, Control Data
Electrical requirements implementation meeting	White Sands, New Mexico	Nov. 30 to Dec. 4	Kalbach	S&ID, NASA
Block II design review meeting	Minneapolis, Minnesota	Nov. 30 to Dec. 4	Maxwell	S&ID, Honeywell
Manufacturing processes, meeting	Farmingdale, L. I., New York	Nov. 30 to Dec. 2	Whiting, Clark, Bell	S&ID, Dielectrix
Crew safety subsystem meeting	Houston, Texas	Nov. 30 to Dec. 14	Stone	S&ID, NASA
Basepoint attitude missions review	Houston, Texas	Nov. 30 to Dec. 2	Myers, Henley	S&ID, NASA
Project engineering coordination meeting	Sacramento, California	Nov. 30 to Dec. 5	Mower	S&ID, Aerojet
F-1 test stand engine mount modification surveillance	Sacramento, California	Nov. 30 to Dec. 1	Carr	S&ID, Aerojet
Engineering coordination meeting	Houston, Texas	Nov. 30 to Dec. 1	Gianformaggio, Antonio	S&ID, NASA
Proposal progress review	Minneapolis, Minnesota	Nov. 30 to Dec. 3	Brannen, Rawding, Maxwell	S&ID, Honeywell
Boilerplate 23 prelaunch checkout support	White Sands, New Mexico	Nov. 30 to Dec. 8	Weinreich	S&ID, NASA
Crew integration subsystem meeting	Houston, Texas	Dec. 1 to 3	Smith, Beam	S&ID, NASA
Design engineering meeting	Minneapolis, Minnesota	Dec. 1 to 3	Wymer	S&ID, Control Data
Spacecraft manufacturing and manufacturing engineering activities, discussion	Huntsville, Alabama	Dec. 1 to 3	Olson	S&ID, NASA
Rendezvous radar and transponder measurement requirements, negotiation	Bethpage, L. I., New York	Dec. 1 to 3	Schmitz, Gilson	S&ID, Grumman
Block II hardware requirements, meeting	Boulder, Colorado	Dec. 1 to 4	Haglund	S&ID, Beech

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S&ID Schedule of Apollo Meetings and Trips
November 16 to December 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Preflight readiness review	Las Cruces, New Mexico	Dec. 1 to 4	Pearce	S&ID, NASA
Modification kit plan, discussions	Houston, Texas	Dec. 2 to 3	Dudek, Marshall, Ogren	S&ID, NASA
Pneumatic valve program review	Sacramento, California	Dec. 2 to 3	Field, Cadwell	S&ID, Aerojet
SPS testing coordination meeting	White Sands, New Mexico	Dec. 2 to 4	Simkin, Goldstein	S&ID, NASA
Spacecraft 001 discussions	Las Cruces, New Mexico	Dec. 2 to 6	Blevins	S&ID, NASA
Fabrication problems, evaluation	Virgennes, Vermont	Dec. 2 to 9	McKellar	S&ID, Simmonds
Flight readiness review meeting	White Sands, New Mexico	Dec. 2 to 11	Helms	S&ID, NASA
Bench maintenance equipment acceptance test procedures, review	Minneapolis, Minnesota	Dec. 2 to 11	Jandrasi	S&ID, Honeywell
Stabilization and control subsystem technical support	Minneapolis, Minnesota	Dec. 2 to 22	Johnston	S&ID, Honeywell
Flight readiness review	White Sands, New Mexico	Dec. 3 to 4	Young, Lish, Thies, Fugikawa, Sweet, Teter, Bajkowski, Lusk	S&ID, NASA
Contract negotiations	Houston, Texas	Dec. 3 to 5	Harrington, Woods	S&ID, NASA
Radio test breadboard inspection	Grand Prairie, Texas	Dec. 4 to 7	Miller	S&ID, Ling-Temco-Vought
Block II radiator design testing	Dallas, Texas	Dec. 6	Daoussis	S&ID, Ling-Temco-Vought
Connector detail design and development review	Salem, Massachusetts	Dec. 6 to 9	Wagner, Waugh, Abbott, Bowers	S&ID, Cannon Electric
System integration during boilerplate 23 postflight period	White Sands, New Mexico	Dec. 6 to 11	Tittle	S&ID, NASA
Coordination meeting	Minneapolis, Minnesota	Dec. 6 to 11	Stiles, Owens, Ferentz, Dyson	S&ID, Honeywell
Boilerplate 23 field operations support	Las Cruces, New Mexico	Dec. 7 to 8	Petrey	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
November 16 to December 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Radar design coordination board meeting	Bethpage, L.I., New York	Dec. 7 to 9	Bond, Koppang, Tanka, Baker	S&ID, Grumman
Intermediate design review meeting	Scottsdale, Arizona	Dec. 7 to 9	Marushak, Hall	S&ID, Motorola
Flight plans and working group meeting	Bethpage, L.I., New York	Dec. 7 to 9	Garton, SeLegue	S&ID, Grumman
Centrifuge program plans, meeting	Houston, Texas	Dec. 7 to 9	Dudek, Hornick, Staniec, Dimitruk, Sargent, Bassett	S&ID, NASA
Modification kit program proposal meeting	Houston, Texas	Dec. 7 to 10	Wright, Kitakis, Bruggerman, Marshall	S&ID, NASA
Technical progress and evaluation meeting	Sacramento, California	Dec. 7 to 11	Mower	S&ID, Aerojet
Design changes, implementation	Newark, New Jersey	Dec. 7 to 11	Knox, Cheshire	S&ID, Weston
Steering committee meeting	Bethpage, L.I., New York	Dec. 8 to 9	Milliken, Gustavson	S&ID, Grumman
Flight and ground test program discussions	Bethpage, L.I., New York	Dec. 7 to 9	Graham, Welsh	S&ID, Grumman
Technical progress discussions	E. Hartford, Connecticut	Dec. 8 to 11	Nash	S&ID, Pratt & Whitney
Engineering coordination meeting	Houston, Texas	Dec. 8 to 11	Tyner, Koos, Gomez	S&ID, NASA
Design verification tests, surveillance	Buffalo, New York	Dec. 8 to 18	Martin, Gunter	S&ID, Bell
Qualification test program meeting	Houston, Texas	Dec. 9 to 10	Wheelock, Fuller	S&ID, NASA
Dynamic motion simulator engineering layouts and test procedures, review	Menlo Park, California	Dec. 9 to 10	Stewart	S&ID, Carco
Apollo service propulsion subsystem meeting	Houston, Texas	Dec. 9 to 11	Field, Cadwell	S&ID, NASA
Digital test command subsystem evaluation and review	Scottsdale, Arizona	Dec. 9 to 11	Wallace	S&ID, Motorola

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S&ID Schedule of Apollo Meetings and Trips
November 16 to December 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Cost status review	Cedar Rapids, Iowa	Dec. 9 to 11	Treman, Hagelberg	S&ID, Collins
Monthly technical interchange meeting	Lowell, Massachusetts	Dec. 9 to 11	Hanifin, Morant, Confer, Statham, Howard, Smith	S&ID, Avco
Dynamic stability data coordination	Houston, Texas	Dec. 9 to 11	Borenstein	S&ID, NASA
Technical coordination meeting	Lima, Ohio	Dec. 9 to 13	Castle, Flint	S&ID, Westinghouse
Displays and controls, review	Bethpage, L.I., New York	Dec. 10 to 16	McCarthy	S&ID, Grumman
Engineering coordination	Bethpage, L.I., New York	Dec. 10 to 17	Osbon	S&ID, Grumman
Scientific equipment for the lunar landing mission, general discussion	Bethpage, L.I., New York	Dec. 13 to 16	Iwasaki, McDonald	S&ID, Grumman
Plans and status technical review	Kalamazoo, Michigan	Dec. 13 to 17	Castner, Butler, Gault, Kirner	S&ID, National Water Lift
Test setup, witness and approval	Wilmington, Massachusetts	Dec. 13 to 20	Voorhis	S&ID, Avco
Technical progress monitoring and evaluation	Sacramento, California	Dec. 13 to 24	Mower	S&ID, Aerojet
Injector status review	Sacramento, California	Dec. 14	Field, Cadwell	S&ID, Aerojet
Block I and Block II G&N measurement requirements meeting	Houston, Texas	Dec. 14 to 16	Funke, Tomita, Schmitz	S&ID, NASA
Bimonthly coordination meeting	Boulder, Colorado	Dec. 14 to 17	Champaign, Bouman	S&ID, Beech
C-band transponder design review meeting	Paramus, New Jersey	Dec. 14 to 17	Kronsberg, McAlister	S&ID, ACF Electronics
Implementation of Block II planning, meeting	Binghamton, New York	Dec. 14 to 18	Frimtzis, Tindal, Rogers, Marshall, Hatchell	S&ID, General Precision
Block II radiator test	Grand Prairie, Texas	Dec. 14 to 18	Levine	S&ID, Ling-Temco-Vought
Program status review	Buffalo, New York	Dec. 15 to 16	Bellamy, Gibb, Wagner	S&ID, Bell

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